California Air Resources Board

Quantification Methodology for the California Department of Transportation Low Carbon Transit Operations Program

Greenhouse Gas Reduction Fund Fiscal Year 2017-18

Note:
The California Air Resources Board (CARB) is accepting public comments on the Draft Low Carbon Transit Operations Program (LCTOP) Quantification Methodology and Draft LCTOP Calculator Tool for Fiscal Year (FY) 2017-18 until December 15, 2017 via GGRFProgram@arb.ca.gov. The Draft LCTOP Quantification Methodology and the Draft LCTOP Calculator Tool are subject to change pending stakeholder comments and final LCTOP Program Guidelines for FY 2017-18. The Final LCTOP Quantification Methodology and LCTOP Calculator Tool will be available on the CARB quantification website at www.arb.ca.gov/cci-quantification.

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December 1, 2017

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Section A. Introduction

The goal of California Climate Investments (CCI) is to reduce greenhouse gas (GHG) emissions and further the purposes of the Global Warming Solutions Act of 2006, known as Assembly Bill (AB) 32. The California Air Resources Board (CARB) is responsible for providing the quantification methodology to estimate the GHG emission reductions and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). CARB develops these methodologies based on the project types eligible for funding by each administering agency as reflected in the program Expenditure Records available at: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/expenditurerecords.htm. CARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified.

For the California Department of Transportation (Caltrans) Low Carbon Transit Operations Program (LCTOP), CARB staff developed this Quantification Methodology and LCTOP Calculator Tool to provide methods to calculate the GHG emission reductions and air pollutant emission estimates of each proposed project (Section B), provide instructions for documenting and supporting the estimates (Section C), and outline the process for tracking and reporting GHG and other benefits once a project is funded (Section D).

This methodology is based on the "Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects"[i] (CMAQ Methods) to estimate the reduction in vehicle miles traveled (VMT) and associated GHG emission reductions based on transportation characteristics of the proposed project. Projects will report the total project GHG emission reductions estimated using this methodology as well as the total project GHG emission reductions per dollar of GGRF funds requested.

In an effort to enhance the analysis, provide greater transparency, and assist in project-level reporting, CARB included an additional output tab in the LCTOP Calculator Tool that summarizes key variables and air pollutant emission estimates for select criteria and toxic air pollutants from LCTOP projects. Key variables estimated include: passenger VMT reductions, fossil fuel use reductions, renewable energy generation and fossil-fuel-based energy use reductions. The LCTOP Calculator Tool calculates air pollutant emission estimates using the same methodology as for GHG emissions estimates for the following criteria and toxic air pollutants: reactive organic gases, nitrogen oxide, fine particulate matter less than 2.5 micrometers, and diesel particulate matter. CARB continues to develop methodologies to assess additional social, economic, and environmental co-benefits achieved by CCI.

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LCTOP Project Types

The Caltrans LCTOP Program reduces GHG emissions through funding transit operating and capital project that meet any of the following:

- Expenditures that directly enhance or expand transit service by supporting new or expanded bus or rail services, new or expanded water-borne transit, or expanded intermodal transit facilities, which may include equipment acquisition, fueling, and maintenance, and other costs to operate those services or facilities;
- Operational expenditures that increase transit mode share; or
- Expenditures related to the purchase of zero-emission buses, including electric buses, and the installation of the necessary equipment and infrastructure to operate and support these zero-emission buses.

Caltrans and CARB determined eligible project types that meet the objectives of LCTOP and achieve GHG emission reductions. Each project requesting LCTOP GGRF funding must include at least one of the following project types:

- New expanded/enhanced transit service;
- Alternative transportation services;
- Free or reduced fares;
- Network/fare integration;
- Purchase expansion zero-emission or low-emission vehicles and equipment in support of new expanded/enhanced transit service;
- Purchase, construct, and/or install infrastructure to support zero-emission or low-emission vehicles in support of new expanded/enhanced transit service;
- Purchase, construct, and install renewable energy for transit facilities in support of new expanded/enhanced transit service;
- Purchase, construct, and/or install passenger amenities at transit stops/stations to encourage increased transit ridership;
- Purchase and construct active transportation facilities that connect to stops/stations and encourage ridership;
- Purchase and install equipment on transit vehicles to encourage increased transit ridership;
- Purchase replacement zero-emission vehicles; or
- Purchase construct, and/or install infrastructure, equipment, or facilities to support zero-emission vehicles.

Section B of this Quantification Methodology details the quantification methods for each project component(s) proposed.

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Methodology Development

CARB and Caltrans developed this Quantification Methodology to be consistent with the guiding implementation principles of CCI, including ensuring transparency and accountability.[ii] This Quantification Methodology is to be used to estimate the outcomes of proposed projects and track results of funded projects. The implementing principles ensure that the methodology would:

- Apply at the project-level;
- Provide uniform methods to be applied statewide, and be accessible by all applicants;
- Use existing and proven methods;
- Use project-level data, where available and appropriate; and
- Result in GHG emission reduction estimates that are conservative and supported by empirical literature.

CARB assessed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for the LCTOP project types. CARB also consulted with Caltrans to determine project-level inputs available. The quantification methods were developed to provide estimates that are as accurate as possible with data readily available at the project level.

Tools

The CMAQ Methods were developed by CARB and Caltrans, and are used statewide by transportation agencies to evaluate criteria pollutant emission reductions from transportation projects competing for State motor vehicle fee and federal CMAQ funding. The CMAQ Methods were used as the basis for developing the GHG emission reduction and air pollutant emission estimates from LCTOP project types. All of the equations and assumptions needed for this quantification methodology are included in this document and assumptions have been modified, as necessary. The CMAQ Methods document can be downloaded from https://www.arb.ca.gov/planning/tsag/eval/eval.htm.

In addition to the CMAQ Methods, this Quantification Methodology relies on CARB-developed emission factors. CARB has established a single repository for emission factors used in quantification methodologies, referred to as the CCI Quantification Methodology Emission Factor Database (Database).[iii] The Database Documentation[iii] explains how emission factors used in CARB quantification methodologies are developed and updated.

Applicants must use this Quantification Methodology, in conjunction with the accompanying LCTOP Calculator Tool, to calculate the GHG emission reductions and air pollutant emission estimates for the proposed projecst. The LCTOP Calculator Tool can be downloaded from: www.arb.ca.gov/cci-quantification.

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Updates

CARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified. CARB updated the LCTOP Quantification Methodology from the previous version[iv] to enhance the analysis and provide additional clarity. The changes include:

- Updates to the GHG emission factors used in calculating emission reductions;
- Updates to the list of eligible project types to provide clarification to applicants;
- Updates to align with other CCI program updates (e.g., include gasoline fuel type for buses, hybrid vehicles, etc.);
- Addition of new output tab in the LCTOP Calculator Tool that summarizes key variables and air pollutant emission estimates; and
- Additional language on reporting after funding.

Program Assistance

CARB and Caltrans staff will review the quantification portions of the LCTOP project applications to ensure that the methods described in this document were properly applied to estimate the GHG emission reductions and air pollutant emissions for the proposed project. Applicants should use the following resources for additional questions and comments:

- Questions on this document should be sent to GGRFProgram@arb.ca.gov.
    - **Note:** If necessary, a frequently asked questions page may be available during the application process, at: www.arb.ca.gov/cci-quantification.
- For more information on CARB's efforts to support implementation of GGRF investments, see: https://www.arb.ca.gov/auctionproceeds.
- Questions pertaining to the LCTOP Program should be sent to LCTOPcomments@dot.ca.gov.

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Section B. Quantification Methodology

Overview

This Quantification Methodology estimates GHG emission reductions and air pollutant emissions based on estimated ridership increases and corresponding passenger auto VMT reductions. Applicants will use the Caltrans Allocation Request form and the CARB Calculator Tool to calculate the total GHG emission reductions and air pollutant emission estimates from the proposed project, as defined in this methodology. In general, the emission estimates are calculated using the following approaches:

Table 1. General Approach by Quantification Method

New Service
$Emission\ Estimates = Emission\ Estimates\ from\ Displaced\ Autos - Emissions\ from\ New\ Service$
Increased Ridership
$Emission\ Estimates = Emission\ Estimates\ from\ Displaced\ Autos$
New Service and Technology Conversion
$Emission\ Estimates = (Emission\ Estimates\ from\ Displaced\ Autos - Emissions\ from\ New\ Service) + (Emissions\ from\ Current\ Vehicle - Emissions\ from\ New\ Vehicle)$
Fuel/Energy Reductions
$Emission\ Estimates = Emissions\ from\ Fuel/Energy\ Reductions$
Technology Conversion
$Emission\ Estimates = Emissions\ from\ Current\ Vehicle - Emissions\ from\ New\ Vehicle$

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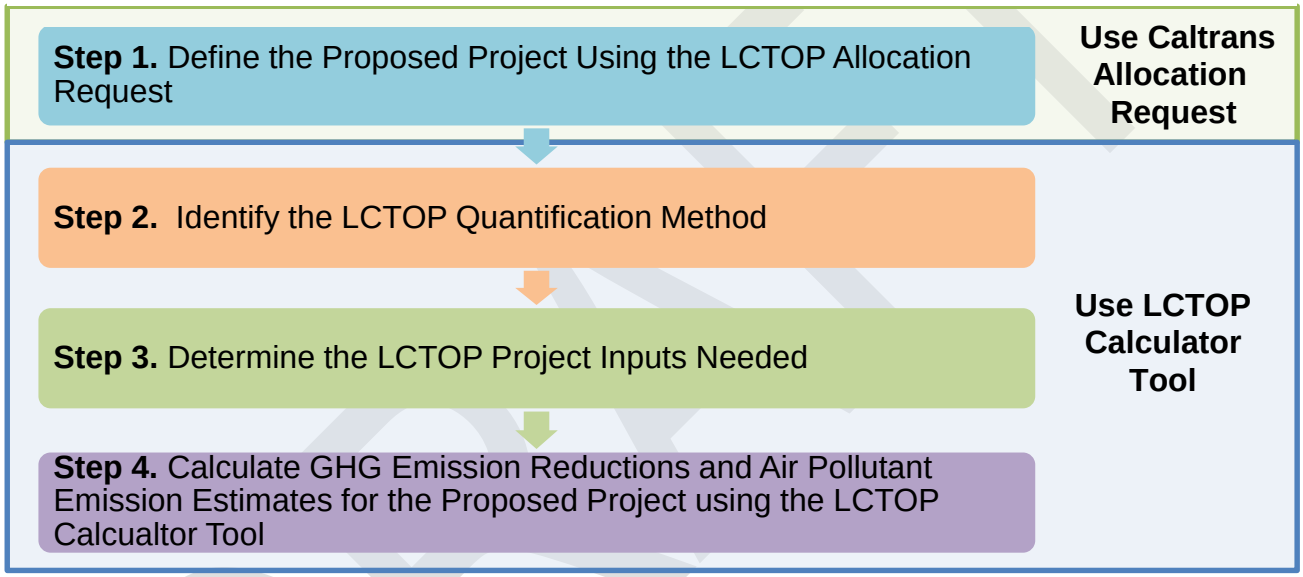
Methods and equations used in the LCTOP Calculator Tool for calculating the GHG emission reductions and air pollutant emission estimates are provided in Appendix B. Emission factors used in calculations are contained in the Database available at: www.arb.ca.gov/cci-quantification. Documentation on the sources and methods used to develop the emission factors are also provided.

Applicants will follow the steps outlined in Figure 1 to calculate the GHG emission reductions and air pollutant emission estimates from the proposed project. Detailed instructions for each step are provided on subsequent pages. An example project illustrating how to use the LCTOP Calculator Tool for a New Service project is included in Appendix A.

Figure 1. Steps to Calculating GHG Emission Reductions and Air Pollutant Emission Estimates



Note: Applicants with more than one project type must complete multiple LCTOP Allocation Requests and LCTOP Calculator Tools to calculate the GHG emission reductions and air pollutant emission estimates from each proposed project type.

Step 1. Define the Proposed Project Using the LCTOP Allocation Request

Applicants must complete the LCTOP **Allocation Request** form in order to complete this step. The LCTOP Allocation Request form can be downloaded from http://www.dot.ca.gov/drmt/splctop.html.

Note: The LCTOP Allocation Request may not be available during the public comment period of the LCTOP Quantifications Methodology and accompanying LCTOP Calculator Tool.

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Step 2. Identify the LCTOP Project Type and Quantification Method

Upon completion of the LCTOP Allocation Request form, applicants will used the LCTOP Calculator Tool to complete Steps 2 through 4.

Eligible LCTOP projects fall into the five quantification methods shown in Table 2. The applicant will use the **Project Types by Method** tab within the LCTOP Calculator Tool to identify the LCTOP Quantification Method for the applicable project type as defined in the LCTOP Allocation Request form. Some projects may have additional GHG emission reductions, such as replacing existing transit vehicle(s) or from fuel/energy reductions.

Table 2. Project Types by Method

Project Type	Method
New expanded/enhanced transit service	New Service
Alternative transportation services	
Free or reduced fares	Increase Ridership
Network/fare integration	
Purchase expansion zero-emission or low-emission vehicles and equipment in support of new expanded/enhanced transit service	New Service and Technology Conversion
Purchase, construct, and/or install infrastructure to support zero-emission or low-emission vehicles in support of new expanded/enhanced transit service	New Service
Purchase, construct, and/or install passenger amenities at transit stops/stations to encourage increased transit ridership	Increase Ridership
Purchase and construct active transportation facilities that connect to stops/stations and encourage ridership	
Purchase and install equipment on transit vehicles to encourage increased transit ridership	
Purchase, construct, and install renewable energy for transit facilities in support of new expanded/enhanced transit service	Fuel/Energy Reductions
Purchase replacement zero-emission vehicles	Technology Conversion
Purchase construct, and/or install infrastructure, equipment, or facilities to support zero-emission vehicles	

Step 3. Determine the LCTOP Project Inputs Needed

The applicant will use the **Required Fields by Method** tab within the LCTOP Calculator Tool, presented as Table 3, to determine the required details needed for input into the LCTOP Calculator Tool for the applicable quantification method identified in Step 2.

Table 3. Required Fields by Method

Input Fields	New Service	Increase Ridership	Fuel/Energy Reduction	Technology Conversion
Project Type	✓	✓	✓	✓
Region	✓	✓	✓	✓
Subregion	✓	✓	✓	✓
Year 1(Yr1)	✓	✓	✓	✓
Year F(YrF)	✓	✓	✓	✓
Service Type	✓	✓		
Project Yr1 Ridership	✓	✓		
Project YrF Ridership	✓	✓		
Adjustment Factor (A)	✓	✓		
Length of Average Trip (L)	✓	✓		
Vehicle Type	✓			
Hybrid Vehicle	✓			
Fuel/Energy Type	✓			
Project Specific Emission Factor	Optional			
Model Year	✓/ Optional			
Annual VMT	✓/ Optional			
Annual Fuel/Energy	✓/ Optional			

Table continued on following page.

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Table 3 (continued). Required Fields by Quantification Method

Input Fields	New Service	Increase Ridership	Fuel/Energy Reduction	Technology Conversion
Additional GHG Reductions	Optional: Fuel /Energy Reductions	Optional: Fuel /Energy Reductions	Fuel /Energy Reductions	Vehicle Replacement
Vehicle Type	✓	✓	✓	✓
Fuel/Energy Type	✓	✓	✓	✓
Model Year	✓/ Optional	✓/ Optional	✓/ Optional	✓/ Optional
Annual VMT	✓/ Optional	✓/ Optional		✓/ Optional
Annual Fuel/Energy	✓/ Optional	✓/ Optional	✓	✓/ Optional
FY 2017-18 LCTOP GGRF Funds Requested	✓	✓	✓	✓
Total LCTOP GGRF Funds Requested	✓	✓	✓	✓
Total GGRF Funds Requested	✓	✓	✓	✓

Key	Description
✓	= Input is required.
Optional	= Applicant must be able to demonstrate an approved carbon intensity value under the Low Carbon Fuel Standard; must submit additional documentation.
✓/ Optional	= Inputs depend on the vehicle type that is selected and may be required.

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Step 4. Calculate the Emission Estimates for the Proposed Project Using the LCTOP Calculator Tool

Applicants must use the LCTOP **Calculator** tab within the LCTOP Calculator Tool to calculate GHG emission reductions and air pollutant emission estimates associated with proposed LCTOP-funded projects. Users should begin with the **Read Me** tab, which contains instructions to calculate GHG emission reductions and air pollutant emission estimates. The **Calculator** tab identifies inputs required by the user, generally requiring project-specific data or assumptions. Key terms are defined under the **Description** column and are described with respect to project type selected. Input and output fields are color coded:

- Yellow fields indicate direct user input is required.
- Green fields indicate a selection from a drop-down box is required.
- Red fields indicate an optional direct user input; additional documentation is required to support entry.
- Grey fields indicate calculation fields that are automatically populated based on user entries and the calculation methods.

Helpful tips to provide clarification or suggested inputs may appear when input cells are selected.

The **GHG Summary** tab displays the estimated:

- GHG emission reduction start date (year);
- GHG emission reductions estimated for the quantification period (i.e., Total GHG Emission Reductions) ($MTCO_2e$);
- Total GHG Emission Reductions/Total GGRF dollar requested ($MTCO_2e/\$$);
- Portion of the GHG emission reductions attributable to funding from another CCI program, as applicable; [1] and
- LCTOP GHG Emission Reductions/LCTOP Funds Requested ($MTCO_2e/\$$).

The **Co-Benefits Summary** tab displays the estimated:

- Passenger VMT Reductions (miles);
- Fossil Fuel Use Reductions;
- Renewable Energy Generation (kWh);
- Fossil Fuel Energy Use Reductions (kWh);
- ROG emission estimates (lbs);
- NO_x emission estimates (lbs);
- $PM_{2.5}$ emission estimates (lbs); and
- Diesel PM emission estimates (lbs).

[1] This is the portion of GHG emission reductions attributable to funding from LCTOP; GHG emission reductions are prorated according to the level of program funding contributed from LCTOP and other CCI programs, as applicable.

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Section C. Documentation

In addition to LCTOP application requirements, applicants are required to document results from the use of this Quantification Methodology, including supporting materials to verify the accuracy of project-specific inputs.

Applicants are required to provide electronic documentation that is complete and sufficient to allow the calculations to be reviewed and replicated. Paper copies of supporting materials must be available upon request by agency staff.

The following checklist is provided as a guide to applicants; additional information may be necessary to support project-specific input assumptions.

	Documentation Description	Completed
1.	Contact information for the person who can answer project specific questions from staff reviewers on the quantification calculations	
2.	Project description, including excerpts or specific references to the location in the main LCTOP Allocation request file (in .xls/.xlsm) of the project information necessary to complete the applicable portions of the Quantification Methodology	
3.	Populated LCTOP Calculator Tool file (in .xls/.xlsm) • Ensure that all fields in the GHG Summary and Co-benefits tabs are populated. • Name the file using this naming convention: "[Lead Agency]_[Project Name]", not to exceed 20 characters.	
4.	Any other information as necessary and appropriate to substantiate LCTOP Calculator Tool inputs	

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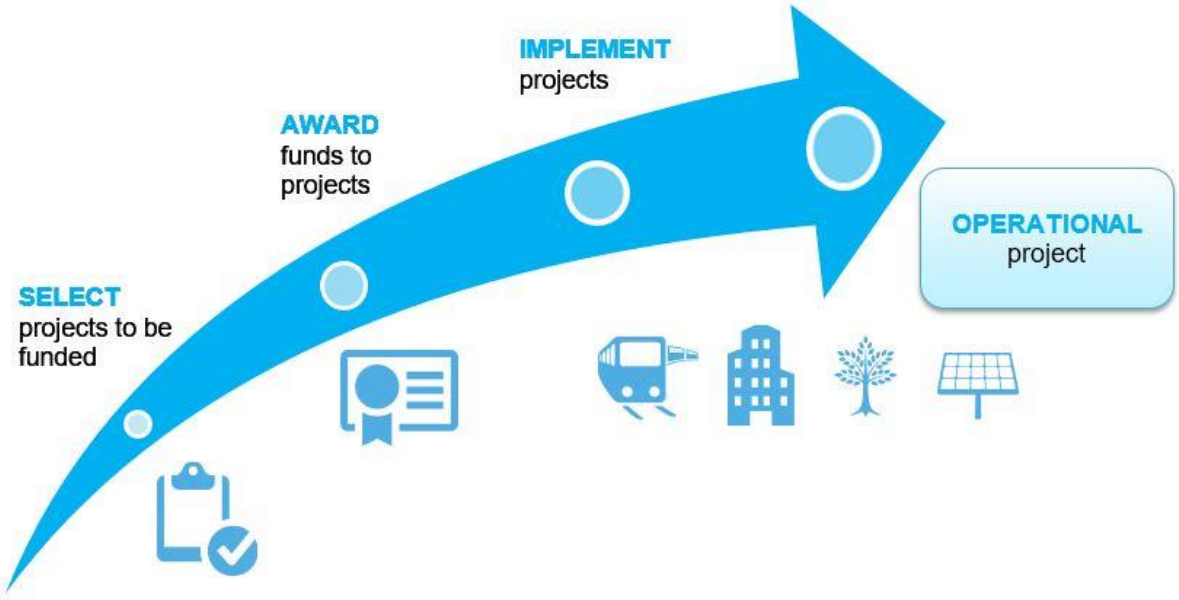
Section D. Reporting after Funding Award

Accountability and transparency are essential elements for all CCI. All administering agencies are required to track project implementation and report on the benefits of those investments. CARB develops tracking and reporting guidance for CCI. The reporting process and requirements are found in Volume 3 of CARB Funding Guidelines.[2] CARB Funding Guidelines Appendices 3.A and 3.B contain detailed reporting requirements that are specific to each project type or administering agency and cover all stages of reporting.

Caltrans will submit periodic reports to CARB. The specific data that need to be reported depend on the project type and the stage of project implementation at the time of reporting. Initially, administering agencies must report basic project information and expected benefits. As projects are implemented, administering agencies provide additional information on project status, benefits, and results. When projects are completed, administering agencies submit project closeout reports. A subset of projects, selected by Caltrans, will report on project outcomes upon reaching a specified milestone and being considered "operational."



Caltrans is required to collect and compile project data from funding recipients, including the GHG emission reductions estimated using this Quantification Methodology, co-benefits, and information on benefits to AB 1550[3] Populations. Reported information

[2] CARB released updated draft Funding Guidelines in August 2017. These draft Funding Guidelines are subject to change based on public input and CARB Governing Board direction. While the draft provides an indication of what is currently required, administering agencies must incorporate all provisions reflected in the draft Funding Guidelines and subsequent Governing Board approved Funding Guidelines.
[3] AB 1550, Gomez, Chapter 369, Statutes of 2016; amending Health and Safety Code Section 39713. Detailed information on AB 1550 requirements is provided in Volume 2 of the draft Funding Guidelines.

will be used to demonstrate how the Administration is achieving or exceeding the statutory objectives for CCI. Key variables and air pollutant emission estimates are highlighted in the Co-benefits Summary tab of the LCTOP Calculator Tool. Funding recipients have the obligation to provide, or provide access to, data and information on project outcomes to Caltrans. Applicants should familiarize themselves with the requirements within the LCTOP Program Guidelines, solicitation materials, and grant agreement, as well as the CARB Funding Guidelines.

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[i] California Air Resources Board (2017). "Cost-Effectiveness Analysis Tools." https://www.arb.ca.gov/planning/tsag/eval/eval.htm

[ii] California Air Resources Board (2017). "Cap-and-Trade Auction Proceeds Funding Guidelines for Administering Agencies." www.arb.ca.gov/cci-fundingguidelines

[iii] California Air Resources Board (2017). California Climate Investments Quantification Methodology Emission Factor Database. Available at: www.arb.ca.gov/cci-quantification.

[iv] California Air Resources Board. Department of Transportation Low Carbon Transit Operations Program Quantification Methodology for FY 2016-2017. January 31, 2017. Available at: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/caltrans_lctop_finalqm_16-17.pdf

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Appendix A. Example Project

Introduction

The following is a hypothetical project[4] to demonstrate how the FY 2017-18 LCTOP Quantification Methodology would be applied. This hypothetical project does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the Proposed Project

The lead agency plans to expand the existing weekday, long distance commuter express service by adding four round-trips per day for one year. The proposed project is determined to be best represented by:

- New expanded/enhanced transit service.

The proposed project has the following project features:

- Operates predominantly within the Sacramento Valley air basin
- First Year (Yr1) of service: 2018
- Final Year (YrF) of service: 2019
- Yr1 Ridership: 62,400
- YrF Ridership: 62,400
- Length of Average Trip (L): 16 miles
- Vehicle Type: 2016 hybrid-diesel Over-Road Coach
- Annual VMT: an additional 37,440 miles are estimated to operate the expanded service
- FY 2017-18 LCTOP funds requested: $93,860
- No additional LCTOP GGRF funds requested
- No additional GGRF funds requested

Where project specific data is not available, CARB defaults are used.

[4] The hypothetical project has not undergone verification of any LCTOP Program requirements; all assumptions about location type and features are for quantification methodology demonstration purposes only.

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Step 1: Define the Proposed Project Using the LCTOP Allocation Request

General Information (Allocation Request Tab)
• Project Name: Expanded Commuter Express Service • Lead Agency: Sacramento Transit • Date Completed: 1/15/2018 • Project ID, if applicable: N/A • Contact Name: John Smith • Contact Phone Number: (916) 555-1234 • Contact Email: john.smith@sactransit.org
Project Specific Inputs (Allocation Request Tab)
• Year 1 (Yr1): 2017 • Year (YrF): 2018 • Yr1 Ridership: 62,400 • YrF Ridership: 62,400 • Adjustment Factor (A): 0.83 (default) • Length of Average Trip (L, miles): 16

Step 2: Identify the LCTOP Project Type and Quantification Method

Project Type	Quantification Method
New expanded/enhanced transit service	New Service

The proposed project type is quantified using the quantification method “New Service” and does not have any applicable additional GHG emission reductions components.

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Step 3: Determine the LCTOP Project Inputs Needed

Calculator Inputs (Calculator Tab)
• Region: Air Basin • Subregion: Sacramento Valley • Yr1: • Service Type: Intercity/Express Bus (Long Distance) • Vehicle Type: Over-Road Coach • Hybrid Vehicle: Yes • Fuel Type: Diesel • Model year: 2016 • Annual VMT: 37,440 • Additional Benefits: Not Applicable • FY 17-18 LCTOP funds requested: $93,860.00 • Total amount of LCTOP GGRF funds requested: $93,860.00 • Total amount of GGRF funds requested: $93,860.00

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Step 4. Calculate Emission Estimates for the Proposed Project Using the LCTOP Calculator Tool

Enter the project information into the LCTOP Calculator Tool **Calculator** tab to estimate GHG emission reductions and air pollutant emission co-benefits.

Inputs		Required	Description
This section is used to determine the quantification method and emission factors to use to estimate emissions.			
Project Type	New expanded/enhanced transit service		
Quantification Method	New Service	Automated	Emission Estimates = Emission Reductions from Displaced Autos – Emissions from New Service
Region	Air Basin	Yes	The region that best encompass the geographic location for the proposed project type.
Subregion	Sacramento Valley	Yes	The air basin where the majority of the service occurs.
Year 1 (Yr1)	2018	Yes	The first year of operation for the new expanded/enhanced service - funded by FY 2017-18 LCTOP funds.
Year F (YrF)	2019	Yes	The final year of operation for the new expanded//enhanced service - funded by FY 2017-18 LCTOP funds.
Quantifcation Period	1	Calculated	The number of years the service is funded by FY 2017-18 LCTOP funds.
This section is used to estimate the emission reductions from displaced auto vehicle miles traveled (VMT).			
Service Type	Intercity/Express Bus (Long Distance)	Yes	The transit service (e.g., Intercity/Express Bus (Long Distance), Light Rail, Vanpool, etc.) directly associated with the the proposed project. For projects that support multiple services, select Multi-modal.
Yr1 Ridership	62,400	Yes	The increase in annual unlinked passenger trips directly associated with the proposed project in the first year.
YrF Ridership	62,400	Yes	The increase in annual unlinked passenger trips directly associated with the proposed project in the final year. If the ridership is not expected to change, the same value should be input for Yr1 and YrF.
Adjustment Factor (A)	0.83	Yes	Discount factor applied to annual ridership to account for transit-dependent riders. Use: documented project specific data or system average developed from a recent, statistically valid survey or default.
Length of Average Trip (L)	16	Yes	Annual passenger-miles over unlinked trips directly associated with the proposed project.
GHG Emission Reductions	413.33	Calculated	The estimated GHG emission reductions in metric ton (MT) of carbon dioxide equivalent (CO2e) from displaced auto VMT from the proposed project.
This section is used to estimate the net emission reductions from new service or from the purchase of new zero-emission/hybrid vehicle(s).			
Vehicle Type	Over-Road Coach	Yes	The vehicle type (e.g., Transit Bus, Streetcar, Ferry, etc.) that will operate the new service.
Hybrid Vehicle	Yes	Yes	Is the vehicle that will operate the new service a hybrid?
Fuel/Energy Type	Diesel	Yes	The fuel type (e.g. Electric, Diesel, etc.) of the vehicle that will operate the new service.
Project Specific Emission Factor		Optional	Applicant must be able to demonstrate an approved carbon intensity value under the Low Carbon Fuel Standard; must submit additional documentation.
Model Year	2016	Yes	The engine model year of the vehicle that will operate the new service.
Annual VMT	37,440	Yes	The estimated annual VMT required to operate the new service (e.g., 72,000). For rail and ferry vehicles, applicants may alternatively use Annual Fuel.
Annual Fuel/Energy		No	Not applicable for this vehicle type.
GHG Emissions	69.63	Calculated	The estimated GHG emissions (MTCO2e) of the vehicle that will operate the new service.
GHG Reductions	343.70	Calculated	The estimated GHG emission reductions (MTCO2e) of the new service.

This section is used to estimate the net emission reductions from vehicle replacement or fuel/energy reductions as a result of the proposed project.			
Additional GHG Reductions	Not Applicable	Optional	Select Not Applicable unless an existing vehicle will be replaced or additional fuel/energy savings may be realized.
Vehicle Type		No	Not applicable for this project type.
Fuel/Energy Type		No	Not applicable for this project type.
Model Year		No	Not applicable for this project type.
Annual VMT		No	Not applicable for this project type.
Annual Fuel/Energy		No	Not applicable for this project type.
GHG Emissions	Not Applicable	Calculated	Not applicable for this project type.
GHG Reductions	Not Applicable	Calculated	Not applicable for this project type.
This section is used to gather the total Greenhouse Gas Reduction Fund (GGRF) funding requested or awarded.			
FY 2017-18 LCTOP GGRF Funds Requested	$93,860.00	Yes	The amount of FY 2017-18 LCTOP dollars the applicant is requesting from Caltrans per State Controller's Office Eligible list for FY 2017-18.
Total LCTOP GGRF Funds Requested	$93,860.00	Yes	The amount equal to FY 2017-18 LCTOP Funds Requested plus all LCTOP dollars from Caltrans that have previously been awarded to the same project and any future LCTOP dollars that the project plans to apply for. If no other LCTOP funds have been requested, the Total LCTOP GGRF Funds Requested will be the same amount as the FY 2017-18 LCTOP Funds Requested.
Total GGRF Funds Requested	$93,860.00	Yes	The amount equal to the Total LCTOP Funds Requested plus all GGRF dollars that have previously been awarded to the same project and any other GGRF dollars that the project has or plans to apply for. If no other GGRF funds have been requested, the Total GGRF Funds Requested will be the same amount as the Total LCTOP GGRF Funds Requested.
This section calculates the greenhouse gas (GHG) emission reductions achieved by the proposed project.			
Total Project GHG Reductions	343.70	Calculated	Total GHG emission reductions ($MTCO_2e$) from the project during the useful life.
LCTOP Project GHG Reductions	343.70	Calculated	This is the portion of GHG emission reductions attributable to funding from LCTOP; GHG emission reductions are prorated according to the level of program funding contributed from LCTOP and other CCI programs, as applicable.

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The **GHG Summary** tab displays the Total GHG Emission Reductions, the Total GHG Emission Reductions per TIRCP and GGRF Funds Requested, which are required documentation components. GHG emission reductions are prorated according to the level of program funding contributed from LCTOP and other CCI programs, as applicable.

	Results	Description
GHG Emission Reduction Start Date (Year)	**2018**	The first year the proposed LCTOP project will achieve GHG emission reductions.
Total GHG Emission Reductions ($MTCO_2e$)	**343.70**	Total GHG emission reductions ($MTCO_2e$) from the proposed project during the quantification period.
Total GHG Emission Reductions /Total GGRF Funds Requested (MTCO2e/$)	**0.0037**	The metric to be reported in the application.
LCTOP GHG Emission Reductions ($MTCO_2e$)	**343.70**	This is the portion of GHG emission reductions attributable to funding from LCTOP; GHG emission reductions are prorated according to the level of program funding contributed from LCTOP and other CCI programs, as applicable.
LCTOP GHG Emission Reductions /Total LCTOP GGRF Funds Requested ($MTCO_2e$/$)	**0.0037**	The metric to be reported in the application.

The **Co-Benefits Summary** tab displays the key variables and air pollutant emission estimates from the project. Key variables and air pollutant emission estimates are also prorated according to the level of program funding contributed from LCTOP and other CCI programs, as applicable.

	Total CCI	Results
Key Variables	Passenger VMT Reductions (miles)	828,672
	Fossil Fuel Use Reductions	-
	Renewable Energy Generated (kWh)	-
	Fossil Fuel Energy Use Reductions (kWh)	-
Co-Benefits	ROG Emission Reductions (lbs)	44.77
	NOx Emission Reductions (lbs)	165.32
	PM2.5 Emission Reductions (lbs)	3.09
	Diesel PM Emission Reductions (lbs)	30.80
	LCTOP	**Results**
Key Variables	Passenger VMT Reductions (miles)	828,672
	Fossil Fuel Use Reductions	-
	Renewable Energy Generation (kWh);	-
	Fossil Fuel Energy Use Reductions (kWh)	-
Co-Benefits	ROG Emission Reductions (lbs)	44.77
	NOx Emission Reductions (lbs)	165.32
	PM2.5 Emission Reductions (lbs)	3.09
	Diesel PM Emission Reductions (lbs)	30.80
	Additional CCI Program	**Results**
Key Variables	Passenger VMT Reductions (miles)	-
	Fossil Fuel Use Reductions	-
	Renewable Energy Generated (kWh)	-
	Fossil Fuel Energy Use Reductions (kWh)	-
Co-Benefits	ROG Emission Reductions (lbs)	-
	NOx Emission Reductions (lbs)	-
	PM2.5 Emission Reductions (lbs)	-
	Diesel PM Emission Reductions (lbs)	-

Appendix B. Equations Supporting the LCTOP Calculator Tool

The GHG emission reductions and air pollutant emission estimates from the project are quantified within the LCTOP GHG Calculator tool using the equations below.

New Service

The GHG emission reductions and air pollutant emission estimates from project types using the New Service method are calculated as the difference between the emissions reductions from displaced autos and emissions associated with the operation of the new service calculated using Equations 1 through 3. Equation 1 is used to calculate the annual VMT reductions from the proposed project and Equation 2 is used to calculate the reductions associated emissions from with auto VMT reductions. Equation 3 is used to calculate the emission estimates associated with the operation of the new service.

Emission Estimates from New Service

$$Emission\ Estimates = Emission\ Reductions\ from\ Displaced\ Autos - Emissions\ from\ New\ Service$$

Equation 1: Annual Auto VMT Reduced in Miles per Year

$$AutoVMT = [(R) * (A) * (L)]$$

Where,			Units
R	=	Annual increase in unlinked passenger trips directly associated with the proposed project	riders
A	=	Adjustment factor to account for transit dependency Use: documented project specific data or system average developed from recent, statistically valid survey or default. Default: 0.5 for local service or 0.83 for long distance service, shuttle and vanpools.	unitless
L	=	Estimated length of average unlinked passenger trip directly associated with the proposed project; calculated as passenger-miles divided by unlinked trips. Applicants may use data reported to National Transit Database for similar service.	mile-rider

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Equation 2: Emission Reductions from Displaced Autos

$$Emission\ Reductions\ from\ Displaced\ Autos = \frac{[(AutoVMT) * (AVEF)]}{CF}$$

Where,			Units
$AutoVMT$	=	Annual auto VMT reduced; calculated using Equation 1	miles
$AVEF$	=	Auto Vehicle Emission Factor	grams/mile
CF	=	Conversion factor	grams/MT or grams/lb

Equation 3: Emissions from New Service

$$Emissions\ from\ New\ Service = \frac{[(NSVMT) * (NSEF)]}{CF}$$

Or (for train/ferry service use only)

$$Emissions\ from\ New\ Service = \frac{[(NSFuel) * (FuelEF)]}{CF}$$

Where,			Units
$NSVMT$	=	The estimated annual VMT attributed to the operation of the new/expanded service	miles
$NSEF$	=	Emission factor based on service type	grams/mile
$NSFuel$	=	The estimated annual fuel attributed to the operation of the new/expanded service - only available for train and ferry services	unit of fuel
$FuelEF$	=	Emission factor based on fuel type	grams/unit of fuel
CF	=	Conversion factor	grams/MT or grams/lb

Increase Ridership

The GHG emission reductions and air pollutant emission estimates from Increased Ridership are calculated as the emission reductions from displaced autos, which can be calculated using Equation 1 and Equation 2.

Emission Reductions from Increased Ridership

$$Emission\ Reductions = Emission\ Reductions\ from\ Displaced\ Autos$$

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Fuel/Energy Reductions

The GHG emission reductions and air pollutant emission estimates are based on the amount of fuel/energy reductions the applicant will realize as a result of a proposed LCTOP project calculated using Equation 5 and 6 respectively.

Emission Reductions from Fuel/Energy Reductions

$$Emission\ Reductions = Emission\ Reductions\ from\ Fuel/Energy\ Reductions$$

Equation 5: GHG Emission Reductions from Fuel/Energy Reductions

$$Emission\ Reductions\ from\ Fuel/Energy\ Reductions = \frac{[(AnnualFuel) * (FuelEF)]}{CF}$$

Where,

			Units
$AnnualFuel$	=	The estimated annual fuel reductions to be realized as a result of the project	unit of fuel
$FuelEF$	=	Emission factor based on fuel type	grams/unit of fuel
CF	=	Conversion factor	grams/MT

Equation 6: Air Pollutant Emission Reductions from Fuel/Energy Reductions

$$Emission\ Reductions\ from\ Fuel/Energy\ Reductions = \frac{[(AnnualFuel) * (FuelCR) * (Fuel\ EF)]}{CF}$$

Where,

			Units
$AnnualFuel$	=	The estimated annual fuel/energy reductions to be realized as a result of the project	unit of fuel
$FuelCR$	=	Fuel consumption rate of the vehicle to realize fuel/energy reductions	miles/unit of fuel
$FuelEF$	=	Emission factor based on fuel type	grams/unit of fuel
CF	=	Conversion factor	grams/MT or grams/lb

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Technology Conversion

The GHG emission reductions and air pollutant emission estimates from the acquisition of cleaner vehicles (i.e., rolling-stock) are calculated based on technology conversion and are equal to the difference between a current vehicle and new vehicle. GHG emissions from the current vehicle and new vehicle are calculated using Equation 4.

For the acquisition of a new zero-emission vehicle, where there is not current vehicle to be replaced, applicants will enter current vehicle information of the newest available diesel-equivalent vehicle. For example, if the project was to purchase a zero-emission vehicle that will be operational in 2019, the applicant will input a 2019 model year diesel vehicle in place of the current vehicle information.

For the acquisition of a new vehicle(s), where there is a current vehicle(s) to be replaced, the LCTOP Calculator Tool requires project specific inputs regarding the current vehicle to calculate the emission estimates.

Emission Estimates from Technology Conversion

$$Emission\ Estimates = Emissions\ from\ Current\ Vehicle - Emissions\ from\ New\ Vehicle$$

Equation 4: Emission Estimates from Technology Conversion

$$Emissions\ from\ Current/New\ Vehicle = \frac{[(AnnualVMT) * (VehicleEF)]}{CF}$$

Or (for train or ferry only)

$$Emissions\ from\ Current/New\ Vehicle = \frac{[(AnnualFuel) * (FuelEF)]}{CF}$$

Where,

			Units
$AnnualVMT$	=	The estimated annual VMT of the vehicle to be acquired	miles
$VehicleEF$	=	Emission factor based on project-specific inputs	grams/mile
$AnnualFuel$	=	The estimated annual fuel of the vehicle to be acquired - only available for train and ferry services	unit of fuel
$FuelEF$	=	Emission factor based on fuel type	grams/unit of fuel
CF	=	Conversion factor	grams/MT or grams/lb

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